Stratigraphic Revision of the Hatchery Creek Sequence (Early-Middle Devonian) Near Wee Jasper, New South Wales

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A new formation (the Corradigbee Formation) is erected for the upper part of the previous 'Hatchery Creek Conglomerate', which is elevated to Group status, its lower part renamed the Wee Jasper Formation. The 'Hatchery Creek Conglomerate', south of Burrinjuck Dam and 50 km northwest of Canberra, was previously defined as a 2.9 km thick sedimentary sequence of conglomerate, sandstone and shale nonconformable on underlying Lower Devonian limestones. The coarser lower part (Wee Jasper Formation) is now estimated at about 1500 m thick; an additional type section is nominated for its upper part, which was not included in the original type section, and lithologies, subdivision, and contacts with underlying and overlying formations are described. The upper sequence of dark shales and mudstones (Corradigbee Formation) has an estimated thickness of about 260 m, with 15 fining-upward cycles in which 50 new fossil sites have been found. Repetition of lower strata of the Hatchery Creek sequence in the west, due to an unrecognised syncline axis through the central part of the outcrop area, had suggested a much greater thickness than interpreted in this study. The relatively high topography of the softer shales and mudstones in the core of the syncline is a transient inverted topography resulting from recently eroded Tertiary basalts. The whole sequence is interpreted as conformable on underlying limestones, and of Emsian-Eifelian age.

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KEYWORDS: Corradigbee Formation, Emsian-Eifelian, Hatchery Creek Group, Wee Jasper Formation.

INTRODUCTION

The previously named 'Hatchery Creek Conglomerate' is a thick sedimentary sequence of Devonian non-marine strata located 50km NW of Canberra (Fig. 1a). It is exposed over an area of about 70 km², with most of its outcrop on the Brindabella 1:100 000 sheet, about 4 km² of which is covered by remnant Tertiary basalt (Owen and Wyborn 1979), and a small northern extension on the Yass 1:100 000 sheet (Cramsie et al. 1978). Underlying marine limestones of the Murrumbidgee Group, in the Goodradigbee valley near the village of Wee Jasper (Fig. 1b), contain an abundant invertebrate fauna, including conodonts, brachiopods, and corals (see Pedder et al. 1970, and references therein). These provide a late Early Devonian (Emsian) maximum age limit for the Hatchery Creek sequence.

The 'Hatchery Creek Conglomerate' was originally assumed to be Upper Devonian in age, based on lithological similarity with the Hervey Group of central New South Wales (Pedder 1967, Conolly, in Packham 1969, Pedder et al. 1970). However a fossil fish assemblage discovered during geological mapping by Owen and Wyborn (1979) was described by Young and Gorter (1981) as probably late Eifelian (Middle Devonian) in age.

Previous authors, when referring to the 'Hatchery Creek Conglomerate', commented on the most accessible lower section, formed predominantly of cycles of massive conglomerate and sandstone. The measured section of Owen and

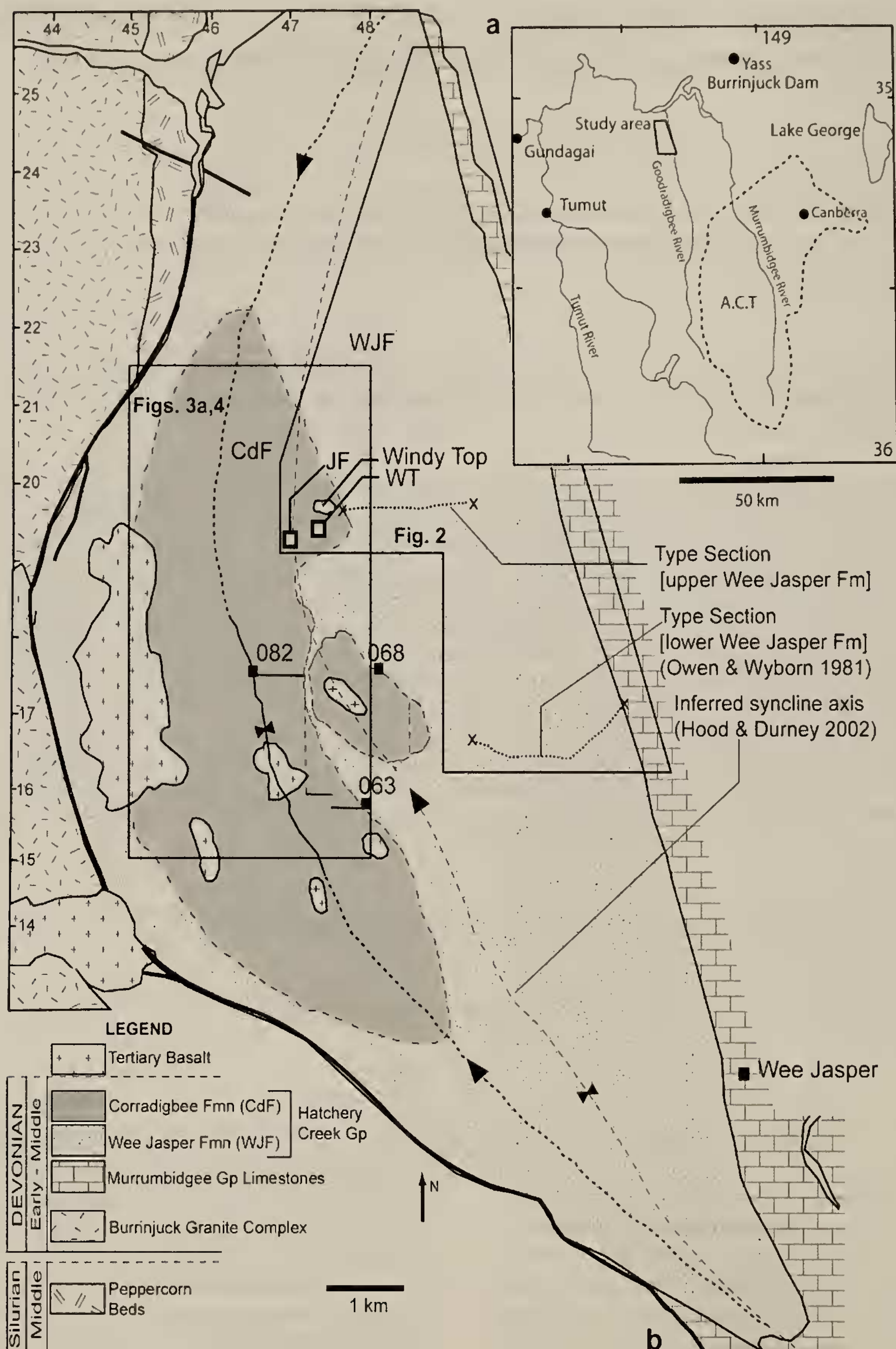


Figure 1. a. Regional locality map showing the study area. b. Generalised geological map showing the outcrop area of the Hatchery Creek Group, based on the Owen and Wyborn (1979) Brindabella 1:100 000 geological map, updated by detailed field mapping (e.g. eastern areas of basalt; large area to west not remapped). Previous fossil localities are the original fish locality at Windy Top (WT) described by Young and Gorter (1981), and a second fish-plant locality (JF) studied by Francis (2003). The syncline axis as identified in this study (on the left) is compared with the position of this structure inferred by Hood and Durney (2002). Boxed study areas are shown in more detail in Figs. 2-4 as indicated.

Wyborn (1979) did not reach into the upper sequence above the lower massive conglomerates (Figs. 1b, 2a). The fossil fish assemblage of Young and Gorter (1981) occurs within the upper finer sequence of siltstones and mudstones, in which almost no conglomeratic horizons are seen. In this paper this upper sequence is separated out as the new Corradigbee Formation, described below, and the lower coarser sequence is renamed the Wee Jasper Formation, both formations included in the Hatchery Creek Group.

A second fossil locality (plants) was recorded on the geological map of Owen and Wyborn (1979). In 1988 an ANU student excursion located fish remains about 4 km south of the original fossil fish locality (locality 59, Fig. 3a), and apparently higher in the sequence. However the faunal composition seemed identical to that from the original fish locality, suggesting problems with the stratigraphy and structure. The plant locality of Owen and Wyborn (1979) was investigated by Francis (2003), where fish were found in association, this locality (JF, Figs. 1b, 2a, 3a, 4b, 5a) being only slightly higher in the sequence than the original fish locality, now called 'Windy Top' (WT, Fig. 1b). Hunt (2005, 2008) conducted a detailed field study of the upper fine-grained sequence (Corradigbee Formation), and discovered many additional fossil localities (Fig. 3a), mainly fish and plant remains, but with a few invertebrates (gastropods, and probable arthropods; see Appendix). New fish taxa in these assemblages (Table 1) include several osteichthyans (bony fish), and a new placoderm genus probably belonging to the arthrodires (Hunt and Young, in press; Young et al. 2010, fig. 4A). Fifteen fining-upward sedimentary cycles were identified, comprising about 260 m of the Corradigbee Formation. The cycles were mapped on both sides of the axis of a broad syncline, a major structure not shown on the geological map of Owen and Wyborn (1979). As a result their estimated total thickness of at least 2900 m for the entire sequence is erroneous. The results presented here conform closely with the first geological investigation of the area, in an unpublished honours thesis by Edgell (1949).

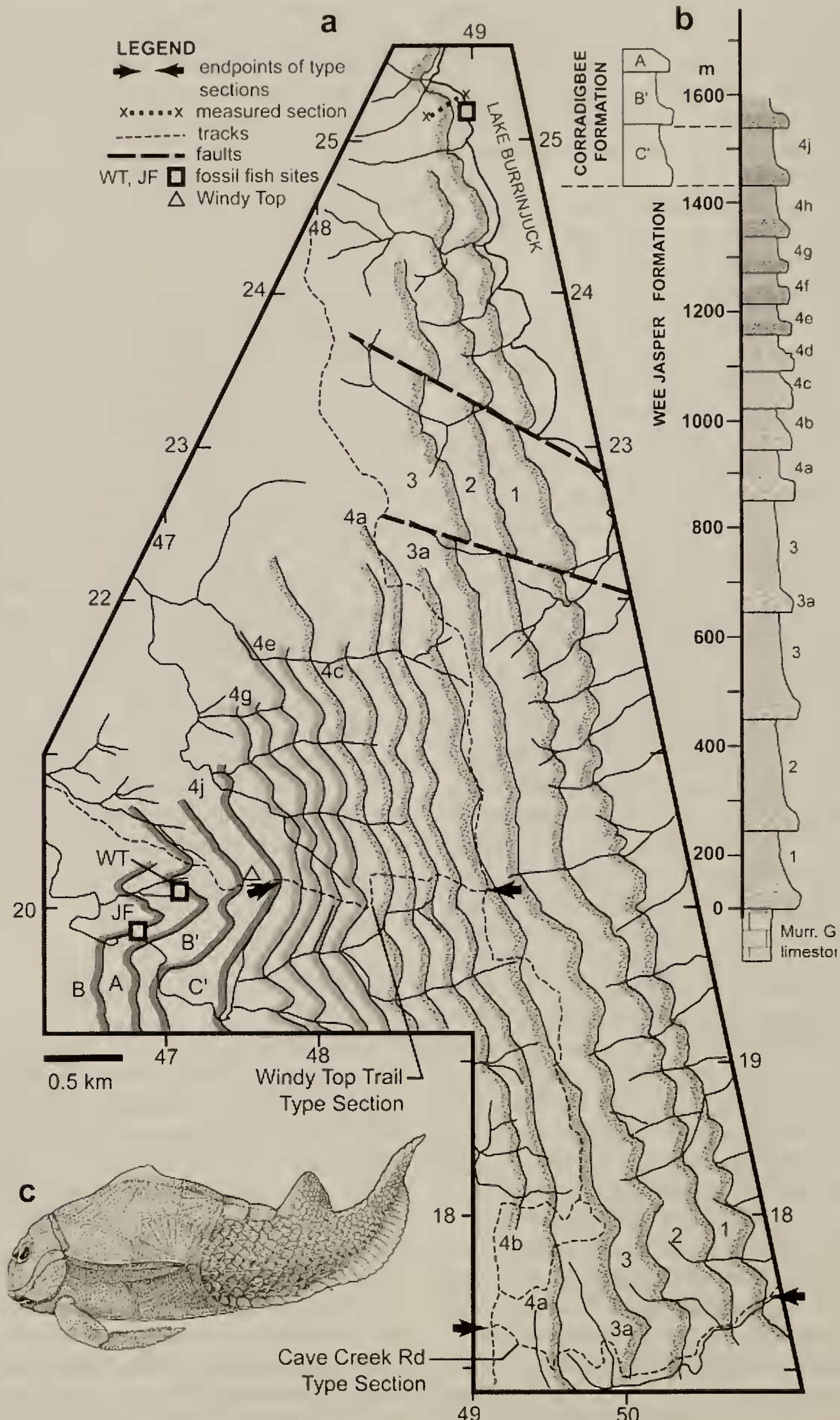
The original fish locality was estimated at about 1.9 km above the base of the sequence, and it was suggested that any disconformity with the underlying limestones was of short duration (Owen and Wyborn 1979; Young and Gorter 1981). Previously, Edgell (1949) had interpreted a conformable boundary between the Hatchery Creek sequence and the underlying limestones, an interpretation now followed here (see below).

Physiographically, the Hatchery Creek area of outcrop is part of the 'Bimberi-Brindabella Upland' of Owen and Wyborn (1979, fig. 5), across which Miocene basalts spread into the mapped area from the 'Kiandra Tableland'. The higher relief of the softer mudstone sequence in the 'middle ridge' of the mapped area of Hunt (2005, 2008; Fig. 3a) probably results from inverted topography. It coincides with the syncline axis, the topographic expression of which has evidently been masked by recent erosion of the cover of Tertiary basalt. Probably the basalt flowed down a previous valley representing the eroded core of the syncline, the basalt cover then inhibiting further erosion until it was eventually stripped off. A small residual cap of basalt remains adjacent to the original fossil fish locality at 'Windy Top' (~700 m elevation, Fig. 1b), with larger outcrops 3-5 km to the south and west (Owen and Wyborn 1979). A flagstone quarry at about 760 m elevation is located in the basalt that forms the highest part of the middle ridge of the mapped area, including Goodradigbee Hill (803 m; Fig. 3a). The area of finer sedimentary rocks was cleared for grazing many years ago, in contrast to the timbered ridges to the east in the coarser sandstone and conglomerates lower in the Hatchery Creek sequence, but since completion of this study has been revegetated as plantation pine forest.

Original access to the main outcrop was up the Cave Creek Road (locked from 2008) and along the 'Main Ridge Trail' to the north, then west along the 'Windy Top Trail' to the original fish locality. Access to 'Corradigbee' homestead (Fig. 3a) is off the access road to the 330kv power transmission line, from the south via the Tumut Road.

METHODS

Reconnaissance mapping of the lower part of the Hatchery Creek sequence by Young (1969) has been reinvestigated during many excursions to collect fossils following the research of Young and Gorter (1981), and associated with the honours project of Francis (2003). The detailed study of Hunt (2005) involved about 30 days field work on the Corradigbee Formation, covering about 20 km^2 in the upper section of the Hatchery Creek sequence (rectangle, Fig. 1b). The softer mudstone sequence is deeply eroded by two north-flowing tributaries of MacPhersons Swamp Creek, here termed 'eastern creek' and 'western creek', separated by the prominent 'middle ridge' (Fig. 3a). Erosion gullies give many good exposures of the softer sediments, and improved exposure and accessibility was a result of the 2003 bushfires in the Wee Jasper area, which burnt blackberry infestations.


a
b
c
LEGEND
endpoints of type sections
x•••••x measured section
tracks
faults
WT, JF fossil fish sites
Windy Top
LAKE BURRINJUCK
CORRADIGBEE FORMATION
WEE JASPER FORMATION
m
Murr. G limestoı
0.5 km
Windy Top Trail Type Section
Cave Creek Rd Type Section

Only some of the more significant fossil material collected from many new localities has been prepared and identified. The original description (Young and Gorter 1981) documented such forms as the placoderm *Sherbonaspis hillsi* (Fig. 2c), which closely resembled the 'winged fish' first described by Hugh Miller (1841) from classic Middle Devonian Old Red Sandstone fish faunas of Scotland. This was the first discovery of such an assemblage from the Southern Hemisphere. An updated faunal list for the Hatchery Creek fish assemblage is given in Table 1; formal fossil descriptions will be presented elsewhere.

For the Corradigbee Formation, various field sites were examined as to the bedding type, dip, strike, lithology and sedimentary structures (see Appendix). Many fining-upward sedimentary cycles could be seen on air photographs by their more resistant basal sandstones, and were traced out on a 90x90 cm photo enlargement. Some identified beds were walked along strike to establish correlations between different exposures for the detailed stratigraphy (Figs. 2a, 4a). Sedimentary strata with good exposure were selected for measured stratigraphic sections using either a tape or 150 cm Jacobs staff and abney level. The cycle containing the original 1981 fossil fish locality (WT) was called Cycle A, with overlying cycles labelled up through the sequence as B, C, etc., and underlying cycles down the sequence labelled B'-F'. The thickness of the Wee Jasper Formation was estimated using aerial photographs and data plotted from the lowest beds of the Corradibee Formation and measured off the maps and photos.

Numbered localities are shown in Fig. 3a and listed in the Appendix. For different field investigations the locality numbers are: 1-24, 59-159 (Hunt 2005); 160-161, 062-082 (Hunt 2008); prefix GY (Young 1969); prefix JF (Francis 2003). All grid references refer to the Wee Jasper 1:25 000 topographic map 8627-4N (second edition, 2003). Full grid references (as in appendix) are abbreviated in the text (e.g. 646385 611805 shortened to GR46385 1805). Fossil material is registered in the ANU palaeontological collection, Canberra (Building 47, Research School of Earth Sciences).

PREVIOUS STRATIGRAPHY

The 'Hatchery Creek Conglomerate', named by Joplin et al. (1953), consists of cyclothems of terrestrial conglomerates, sandstones and mudstones. These fine upwards and the beds are laterally extensive, some being traceable over several kilometres along the length of the outcrop (Young 1969). These beds can be classified as red beds according to the definition of Van Houten (1973).

Owen and Wyborn's (1979) estimated thickness of about 2.9 km for the Hatchery Creek Conglomerate was followed by other authors (Young and Gorter 1981; Branagan and Packham 2000; Packham 2003). With the subdivision of this sequence into two formations as proposed here (the Wee Jasper Formation and the Corradigbee Formation), and the recognition that the previously interpreted upper ~300 m of coarse sandstones and conglomerates is in fact a repetition of the lower strata (Wee Jasper Formation) on the western limb of a syncline, a significantly reduced total thickness estimate of 1760 m for the Hatchery Creek Group is based on the following: thickness for the lower formation (Wee Jasper Formation) estimated from air photos (average dip 40°) at about 1500 m; thickness for the upper Corradigbee Formation (as defined below) estimated at 260 m.

HATCHERY CREEK GROUP (UPGRADED FROM FORMATION)

WEE JASPER FORMATION (NEW NAME)

The first published description (as 'Hatchery Creek Conglomerate') recorded numerous fining-upward conglomeratic cycles (Owen and Wyborn 1979: microfiche M314-M320). A type section comprising about 1200 m of almost continuous exposure of cycles of 'conglomerate, sandstone and siltstone typical of the lower part of the formation' was nominated along the Cave Creek Road (see Fig. 1b), from the basal contact with the underlying carbonates at their stated grid reference (GR509 176), to the top at the T-junction of the Cave Creek

Figure 2 (LEFT). a. Detailed geological map of the Wee Jasper Formation (previously Hatchery Creek Conglomerate, lower part) between the original type section (Cave Creek Road) for the lower part defined by Owen and Wyborn (1979), and the new type section for the upper part (Windy Top Trail) described in the text. Coarser basal part of each fining-upward unit indicated by stippling or shading. b. Summary section for the lower 1600 m of the Hatchery Creek Group, showing correspondence between the upper cycles of the Wee Jasper Formation and lower cycles of the Corradigbee Formation. c. Reconstruction of the placoderm fish *Sherbonaspis hillsi* Young and Gorter (1981), which established a probable Eifelian age for the Hatchery Creek sequence.

Road and Main Ridge Trail (their GR491 172; Fig. 2a). Owen and Wyborn (1979) noted a change at about 1500 m above the base of the formation to a lithology dominated by fine buff sandstone and red siltstone with root casts. They considered but did not follow the stratigraphic subdivision first proposed by Edgell (1949), who separated off this finer upper sequence as the 'Middle Ridge Shales' from the lower 'Wee Jasper Creek Conglomerates' (also overlooked by Packham 1969; Pedder et al. 1970).

Young (1969) had previously subdivided the lower 1550 m of the Hatchery Creek Conglomerate into four units, the lower Units 1 and 2 forming the eastern slope of the main ridge along the western margin of the Goodradigbee valley, and the upper Units 3 and 4 mainly outcropping in the western drainage of Macphersons Swamp Creek. The top of the formation was left undifferentiated. This subdivision has been checked in the field since 2003, supported by air photo interpretation using new colour air photos, and more recently Google Earth images, as summarised in Figure 2a. Estimated thickness from the base for these four units was 250, 200, 400 and 700 m (Young 1969). Owen and Wyborn (1979) stated that the cycles as defined by the beds of conglomerate rarely extend beyond about 1 km, but some of the units mapped by Young (1969), for example the prominent basal conglomerates of Units 1 and 2, can be traced on air photos nearly 10 km along the western escarpment of the Goodradigbee valley (Fig. 2a). The basal conglomerates of Unit 2 form a row of conspicuous outcrops about one third of the distance up the slope of each spur between about GR495 210 and GR492 220. Both horizons can be traced north (with two slight fault displacements at about GR495 222 and GR492 232) at least to GR490 245. Unit 3 crops out near the top and over the ridge to the west.

To the south, prominent outcrops of three ridges north of the road in the Cave Creek Road type section of Owen and Wyborn (1979) can be assigned to the basal coarse beds of Units 1-3 (between GR509 174 and 504 171). The basal conglomerate of Unit 3 can be readily traced on air photos from GY52 (GR499 193) to a prominent knoll on the spur at GR497 197, and then to the crest of the main ridge between GR492 208 and 489 219. Farther north a sharp bend to the west in the track crosses the basal conglomerate of Unit 4 at GR4855 221. This basal conglomerate is readily traced along strike to the south as a series of prominent outcrops between valleys (e.g. GR487 2125, 487 208), and forms the first outcrop of conglomerate encountered after the turnoff into the eastern end of the Windy Top track, at GR489 2015.

Since the existing type section finishes well below the lithological change to much finer sediments (the base of our new formation), we nominate an additional type section for the upper part of the renamed Wee Jasper Formation, along the Windy Top Trail from its junction with the main track at GR491 201, to the vicinity of the locked gate at Windy Top (GR477 2016), about 1.4 km to the west. This is accessible by 4-wheel drive vehicle, and the valleys to the north and south display a thick section of alternating coarse and fine beds as mapped by Young (1969). From the eastern end of this type section, down the spurs into the Goodradigbee valley, air photos clearly show the base of Unit 3 at GR494 201, the base of Unit 2 at GR496 2065, and the base of the Hatchery Creek Group (and Unit 1 of the Wee Jasper Formation) on the edge of the treeline at GR5012 202.

Owen and Wyborn (1979) recorded a fine-grained sequence between about 1500-2600 m above the base of their Hatchery Creek Conglomerate, then a return to cyclic conglomerates about 300 m thick at the top of the sequence. However our more detailed mapping has shown this interpretation to be incorrect, these 'upper' conglomerate cycles in fact representing a repetition of the contact between the Wee Jasper Formation and the Corradigbee Formation on the western limb of the syncline. The western contact (running beneath the largest basalt outcrop; Fig. 1b) was not mapped in detail, but approximates to the corresponding formation boundary of Edgell (1949). The most westerly discovered fossil site (Fig. 3a, locality 160; with fish and plants) is still in the Corradigbee Formation. Further west, light yellow sandstones of the Wee Jasper Formation were observed in the vicinity of GR449 174, but to the north similar horizons are more conglomeratic where they emerge from beneath the basalt (near GR450 203). A similar increase in coarseness to the north was observed on the eastern limb of the syncline (see below). The uppermost coarse layers of the Wee Jasper Formation are exposed within the main outcrop of the Corradigbee Formation, in the creek bed along a section of the Western Creek (dashed line, Fig. 5a), but too narrow to be shown on the geological map (Fig. 1b). Here, the lower levels of the Corradigbee Formation beneath measured section 2 (see Fig. 3) are inaccessible with a steep drop down to the creek bed.

Lower and Upper Contacts

Various authors have commented on the nature and significance of the contact between the Hatchery Creek sequence and the underlying marine limestones, but only some of these were based on actual field investigations. Young (1969, p. 47) discussed the upper limestone boundary, noting that the uppermost Unit 6 of his 'Upper Reef Formation' was generally poorly exposed because of high clay content, and was covered by scree from the much more prominent overlying 'Hatchery Creek Conglomerate' (now Wee Jasper Formation). Where Unit 6 had continuous exposure on the western shore of Lake Burrinjuck, north from about GR491 243 around to the mouth of Hatchery Creek, the beds were highly sheared in the vicinity of the fold axis. The same applies at the southern fold closure in the vicinity of the Long Plain Fault south of Wee Jasper, obscuring sedimentary changes at the boundary.

Young (1969) noted there was no change of strike across the boundary, and no limestone clasts were observed in the basal conglomerate. However, in four measured sections across this interval there was a marked difference in thickness of the uppermost Unit 6, from 80 m in the south at GY39 (GR520 136), 210 m at GY40 (GR508 183), 140 m at GY43 (GR499 210), and 110 m at GY44 (GR494 230). This thickness variation was attributed to slight warping (less than 1°) before deposition of the conglomerate, indicating a disconformable contact. Pedder et al. (1970, p. 210) independently provided similar evidence for a disconformable contact, noting that the 'Hatchery Creek Conglomerate' (Wee Jasper Formation) on the eastern limb 'rests more than 250 feet above the highest assemblage zone of the Taemas Formation, whereas on the western limb it may rest less than 100 feet above the *Hexagonaria smithi smithi* Teilzone'. They also noted that 'the lithologies of the two formations belong to entirely distinct megafacies'. Owen and Wyborn (1979, M320) also favoured a disconformable contact on the evidence of thickness variation in the uppermost unit of the Taemas Limestone, but suggested, from the age evidence of the overlying fish assemblage (subsequently published by Young and Gorter 1981), that a 'disconformity – if present – represents a short time duration'.

Subsequent to these field investigations a new track was cut around the western shore of the lake at the northern end of the Goodradigbee valley. This gave much improved exposure of this contact in the vicinity of GR488 252, an important fossil fish locality in the limestone (Fig. 2a). Here, Campbell and Barwick (1999) measured a section through the contact, the uppermost beds of the Taemas Limestone comprising about 110 m of thin-bedded limestones and shales 'interpreted as an intertidal zone carbonate deposit consistent with the fact that the overlying unit is the fresh water Hatchery Creek Formation' (p. 125). Lindley (2002, fig. 4) presented a revised version of this section, with the uppermost unit beneath the conglomerate assigned to Unit 6 of the 'Upper Reef Formation' of Young (1969), and Campbell et al. (2009, p. 62) noted that the top of carbonate sequence with shallow marine algal mats was 'transitional into the overlying fresh water Hatchery Creek Formation'.

Although uncertainty about this boundary was indicated in stratigraphic sections of Basden et al. (2000, fig. 2) and Young and Turner (2000, fig. 3B), the new evidence just summarised is accepted as indicating a conformable contact at the base of the Hatchery Creek Group. The thickness variations in the uppermost limestone units noted above must therefore be interpreted as a depositional feature. This complies with the original opinion of Edgell (1949, p. 10) that interbedded lithologies at the contact indicated continuous deposition.

The upper contact of the Wee Jasper Formation (and base of the new Corradigbee Formation as defined below) is at the top of Cycle D' of Hunt (2005). This is the highest cycle observed with conglomerate/coarse pebbly sandstone forming the basal unit, all higher cycles having sandstone at the base (the rare thin conglomerates described below for the Corradigbee Formation were within a cycle, not at the base). It is noted that coarse beds persist to the top of the Wee Jasper Formation in the vicinity of localities 062 and 068 (Fig. 2a), but farther south the equivalent beds seem less coarse, the contact being less clearly defined, and recognised by a change in colour rather than grainsize (discussed below).

Subdivision

The general outcrop of the Wee Jasper Formation is indicated in Figure 1b, and a refined version of Young's (1969) subdivision into four units is detailed in Figure 2. As noted above, the coarser basal unit of each cycle (normally about 30-40 m thick), can generally be traced with confidence on air photos, although individual beds may pinch out along strike. For example a prominent ridge just west of the Main Ridge Trail at GR495 190 (Fig. 2a) is the next resistant set of beds above the base of Unit 3, it forms the main ridge for about 1 km along the track to the south, but is less clearly differentiated in the Cave Creek type section (Unit 3a, Fig. 2a). To the north it is traceable to a similar prominent ridge immediately east of the track at GR492 199, and it also crosses the track at the Windy Top Trail turnoff. It forms prominent outcrops immediately west of the track between GR490 208 and 4895 213, before it is crossed by the track again at about GR488 219, where it is less distinct. This is a distance of about 3 km along strike for what

Table 1. Faunal list for the Hatchery Creek fish assemblage (updated from Young and Gorter 1981).

Agnatha
Thelodontida
1. *Turinia* sp. cf. *T. hutkensis* Blieck & Goujet (Young & Gorter 1981)

Gnathostomata
Acanthodii
2. climatiid gen. et sp. indet.
3. ?diplacanthiform gen. et sp. indet.
4. *Tareyacanthus* sp. cf. *T. magnificus* Valiukevicius (Burrow 2002)
5. *Watsonacanthus*? sp.

Osteichthyes (Sarcopterygii)
6. *Gyroptychius*? [new genus] *australis* Young & Gorter, 1981
7. osteolepiform gen. et. sp. nov. 2 (Hunt 2008)
8. osteolepiform gen. et. sp. nov. 3 (Hunt 2008)
9. ?onychodontid indet.

Placodermi
Arthrodira
10. *Denisonosteus weejasperensis* Young & Gorter, 1981
11. cf. *Denisonosteus* sp. nov. (Hunt 2005)
12. coccosteomorph cf. *Coccosteus* (Hunt 2008)
13. ?arthrodire gen. et. sp. nov. Hunt and Young, in press.
14. Arthrodira incertae sedis

Antiarcha
15. *Sherbonaspis hillsi* Young & Gorter, 1981
16. cf. *Sherbonaspis* sp. nov. (Hunt 2005)
17. *Monarolepis verrucosa* (Young & Gorter 1981) Young, 1988

is interpreted as a laterally discontinuous coarser interval in the middle part of Unit 3.

The overlying recessive zone, representing the top of Unit 3 at its boundary with the basal conglomerate of Unit 4, is more persistent along strike, being traceable over about 5 km back to the Cave Creek Road type section. In the north it is crossed at a sharp turn in the Main Ridge Trail at GR4855 221, it can be followed south to GR4893 2015 (Windy Top Trail), GR490 1955 (next valley south), GR4955 180 (east-west section of Main Ridge Trail), and GR4955 1705 (Cave Creek Road type section).

Above this in the Cave Creek Road type section, the coarse basal part for the overlying Unit 4 as mapped by Young (1969) corresponds to a sharp bend in the Cave Creek road at GR495 170. Unit 4 is subdivided into 9 fining upward cycles (4a-j), the upper parts of which correspond to the five 'thin zones of low weathering resistance' mapped by Young (1969). These are readily identified on recent air photos in the valleys to the north and south of the Windy Top Trail, designated here as type section for the upper part of the Wee Jasper Formation. The basal conglomerate/pebbly sandstone of Unit 4 (cycle 4a) is about 40-50 m thick, fining up into a poorly outcropping interval of similar thickness, the latter clearly visible on air photos as a continuous less resistant zone from GR4845 224 south to the Windy Top Trail type section. Here it separates the basal conglomerate of Unit 4 at GR489 2015, and the basal coarse beds of the second cycle, encountered at the first bend in the track (GR488 202). This is the lowest of three similar fining upward cycles (4b-d) crossed by the track before a sharp southerly bend at GR4935 202. Each cycle is estimated at about 70 m thick, with the coarse resistant beds comprising more than half the thickness (4b, c), or about half (4d). These three units are well exposed in the next creek to the south, between about GR485194 and 490 196.

On air photos (and 'Google Earth') the E-W sections along the valleys of the three creeks to the north of the Windy Top Trail clearly show the alternating resistant and five recessive beds of Unit 4 as mapped by Young (1969). The undifferentiated upper part of the 'Hatchery Creek Conglomerate' of Young (1969) approximates to the Corradigbee Formation as defined below. The upper part of cycle 4c is the lowest of the five 'less resistant mudstones' mapped by Young (1969), and can be traced to the north at least as far as the vicinity of GR478 222.

The recessive upper part of cycle 4d thickens along strike to the north of the Windy Top Trail, in the vicinity of GR483 205. The overlying four cycles (4e-h) in this valley (the first creek north of the track, between GR490 205 and GR475 206) are seen as narrow ridges separated by less resistant bands of equal or greater width. Most can be traced farther north to the valley section of the creek between GR476 216 and GR487 216, where the resistant bands are thinner and recessive bands correspondingly thicker. The base of cycle 4e is traceable to the south to cross the Windy Top Trail immediately west of the sharp bend at GR483 200. Where the northern creek turns to the north-west at GR476 216 the creek has eroded along the upper recessive bed mapped by Young (1969). This is the upper part of cycle 4f, traceable back to GR481 2005 on the Windy Top Trail. The basal coarse bed of cycle 4g is the lowest of three apparently thicker fining-upward cycles (4g,h,j) along the Windy Top Trail, their finer upper parts forming gullies immediately to the south. However further south between about GR475 194 and GR482 194 these beds are more differentiated, and the less weathered outcrop along the track may be due to relatively recent exposure by removal of the overlying basalt. The uppermost of these units (4j) passes beneath the remnant basalt cap of Windy Top (Fig. 4b).

The correspondence between the uppermost cycle 4j in the Windy Top Trail type section, and Cycle C' of the Corradigbee Formation as mapped in the area farther south by Hunt (2005), is indicated in Figure 2b. Cycle C' is the lowest horizon in which fish remains were found to the south, and in the gully just south of the locked gate at Windy Top some arthrodire fish fragments (ANU V2270) were found at about GR476 200 by G. Young and A. Warren in 1986, the equivalent lowest fish horizon in this section. The interpreted correspondence between the uppermost cycles identified are summarised in Fig. 2. Figure 4b shows a view from the south towards Windy Top, outlining the constituent units representing uppermost cycles of the Wee Jasper Formation, and the lowermost cycles of the Corradigbee Formation.

Lithologies and sedimentary structures

Owen and Wyborn (1979: M314-M320) noted numerous fining-upward conglomeratic cycles in their type section. These varied in thickness from 1 to 20 m, partly due to upper beds in many cycles being truncated by erosion such that one conglomerate rested directly on the conglomerate of the preceding cycle. A complete cycle was described in terms of three lithologies. At the base they described a reddish brown conglomerate, showing scoured contact with the top of the preceding cycle, and including subrounded to rounded pebbles and cobbles of quartzite, quartz, chert, rhyolite and minor granitic rock, with clay clasts and pellets. This was overlain by reddish purple sandstone, usually thin-bedded and flat-bedded, with local foreset cross-bedding (at about 20°). At the top of each cycle an upper red siltstone/mudstone was described, with round whitish mottles, containing root casts which bifurcate downwards, extensively bioturbated in the upper part with bedding sometimes completely destroyed, colour bleached around numerous root casts; and rare wood tissue.

These cycles in turn make up the larger fining-upward units mapped by Young (1969). The lowest Unit 1 was described as 1-2 m thick conglomerates interbedded with coarse lithic arenites for the lower 70 m, fining upwards into interbedded yellow sandstones and red siltstones and mudstones. Unit 2 (thickness ~200 m) and Unit 3 (thickness ~400 m) are similar fining upwards units, the basal conglomerate of the latter exhibiting large scour and fill structures at GY52 (GR499 1935), large scale cross-bedding was recorded in overlying sandstones, and mudcrack polygons in the upper part of Unit 3. Unit 4 (~700 m) is generally finer grained, comprising more resistant intervals 40-100 m thick separated by at least nine thin zones of less resistant material summarised in Figure 2b. In outcrop the more resistant strata are pebbly sandstones up to 3 m thick interbedded with red mudstone of similar thickness, although considerable variation was observed (Young 1969, p. 50). The thin less resistant intervals, where examined at two localities (GY50, 51, GR484 208, 4795 209), are very distinct zones of no outcrop and sparse vegetation about 10 m across, forming well defined saddles on the crest of each ridge, with poor soil of coarse red mudstone gravel presumably derived from a friable red mudstone.

CORRADIGBEE FORMATION (NEW FORMATION)

The change in lithology at about 1500 m recorded by Owen and Wyborn (1979) was described as follows: the conglomerate portion of each cycle becomes less important, contains smaller pebbles, and in places is absent, and the sequence is dominated by fine buff sandstone and red siltstone with root casts. This finer upper part approximates to the upper formation of Edgell's (1949) stratigraphic subdivision, and to the new formation defined here, named after the property (*Corradigbee*; GR64699 61166 on the Wee Jasper 1:25 000 topographic map 8627-4N, 2nd edition) that encompasses much of its outcrop. Previous studies referred to this unit as the 'upper Hatchery Creek Formation' (Young and Gorter 1981; Francis 2003; Hunt 2005), or 'upper beds of the Hatchery Creek Conglomerate' (Owen and Wyborn 1979).

Detailed mapping in the study area of Hunt (2005) revealed at least 18 sedimentary cycles in this finer upper part, of which 15 are assigned to the Corradigbee Formation. The base of its type section (Figs. 1b, 3a) is at locality 063 (GR47598 17285), and the top is at locality 082 (GR46644 18456). The 231.5 m section was measured in three parts, and the composite section is given in Figure 3b.

Lower and upper contacts

The boundary between the Wee Jasper Formation and the overlying Corradigbee Formation is defined at the base of the fourth lowest cycle (Cycle C'). Cycles D' - F' of Hunt (2005) correspond to the upper cycles of the Wee Jasper Formation as described above (Fig. 2). The base of Cycle C' is a fine sandstone, which is a marked sediment change from the basal conglomerates or coarse pebbly sandstones of all lower cycles. This lithological change was observed in the northern part of the field area at locality 068 (GR47793 18228), extending to the north in the gullies immediately south of the Windy Top type section. However, in the southern part of the mapped area of Hunt (2005) the underlying Wee Jasper Formation appears generally less coarse than in the north, although these upper beds were not mapped in detail. Along the access track into *Corradigbee* homestead south of Goodradigbee Hill (Fig. 3a) yellow sandstones predominate, and conspicuous conglomerate or coarse sandstone strata were not seen. The first conglomerates observed were farther to the east (lower in the sequence) along the main road (under the transmission line) in the vicinity of GR475 155. In the vicinity of locality 063 (base of the Corradigbee Formation type section), the formation boundary was identified as a consistent colour change, the underlying sediment (assigned to the Wee Jasper Formation), including coarse grained sandy-mudstone (containing root casts, bioturbation), with a general very light yellowish brown colour. In contrast, the overlying interbedded red and grey mudstones containing fossil fish and plant material (assigned to the Corradigbee Formation) is generally much darker in colour. As a general impression the grey mudstones seem to become darker in cycles towards the middle part of the formation.

The uppermost horizons of the Corradigbee Formation (K–M; see Fig. 4a) are exposed at localities only in the core of the syncline, and only in the southern part of the study area where erosion has been impeded by the basalt cover. Another section was measured on the western limb of the syncline to include these upper cycles (Section 2, Fig. 3b). The uppermost cycle M is inferred from a basal sandstone overlain by about 2 m of mudstone before cover by basalt scree. Thus the estimated thickness of the Corradigbee Formation (260 m) is a minimum estimate, because erosion before the basalt was deposited is unknown.

Subdivision

Owen and Wyborn (1979) recorded at least three grey sandstone – mudstone cycles in the upper fine-grained part of the sequence, said to be less than 30 m thick and of limited lateral extent, each comprising several sedimentary cycles. With more detailed mapping, 15 sedimentary cycles are now identified in the Corradigbee Formation, labelled from the base to the top C′ to M (Fig. 3b), the original 1981 fossil fish locality (WT) being in the third cycle from the defined base of the formation (Cycle A). These cycles are interpreted as cyclothems (i.e. an asymmetrical repetition of sedimentary layers; Weller 1960). They were first identified on air photographs by their basal sandstones, which had a thickness greater than 20 cm. Two part sections were measured (sections 1a, 2, Fig. 3b), and compared with the type section to demonstrate a similar sequence of cycles on both sides of the syncline axis.

Cycle thickness varies, many being 12-15 m thick, with an increase in thickness in the middle part of the formation (Fig. 3b). This indicates either variation in the period of time represented by each cycle, or more likely variation in sediment supply, with the thicker upper cycles reflecting increasing fine over coarse material. These cycles indicate a repetitive sequence of climatic or depositional conditions over the area, presumably representing considerably longer time intervals than annual cycles.

Lithologies and sedimentary structures

Owen and Wyborn (1979) described each fining upwards cycle in terms of three lithologies: i) thin basal medium grey coarse sandstone which contained

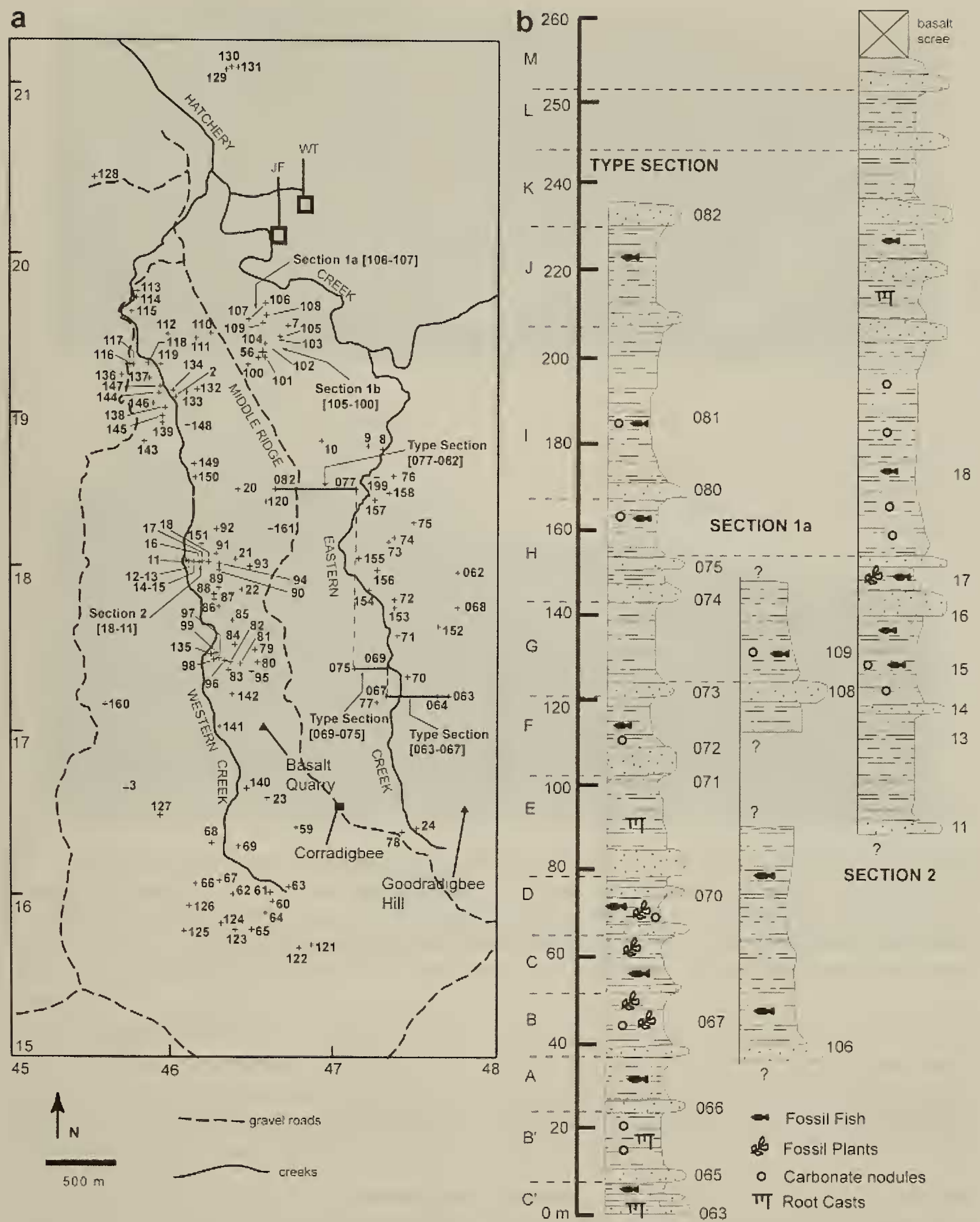


Figure 3. a. Locality map for the study area of the Corradigbee Formation (base map Wee Jasper 1:25000 topographic map 8627-4N [second edition]). Previous fossil localities (JF, WT) and measured sections indicated. For locality details see Appendix. b. Three measured sections through the Corradigbee Formation and suggested correlations. Locality numbers shown on the right of each section.

Figure 4. a. View to the southwest from near the original fish locality at Windy Top, showing main cycles of the Corradigbee Formation and position of measured sections. b. View to the north showing the original fish locality (WT) to the west of the basalt cap at Windy Top, in the lower part of Cycle A. The second fossil locality (JF, lower left) is in the upper part of the same cycle. Upper beds of the Wee Jasper Formation (WJF) in the Windy Top type section shown to the right of the figure.

small subangular to subrounded pebbles; ii) thin fine to medium-grained sandstone also including small pebbles, and fish and plant fossils in one of the cycles showing little evidence of abrasion, with fish plates apparently not parallel to bedding, indicating that the sandstone formed as a single bed; iii) an upper dark grey to black massive mudstone up to 2 m thick, containing vascular plant remains, rare fish remains at the base, and grey-white limestone nodules in the upper part, some containing microscopic fish remains, and with mud cracks on upper bedding surfaces.

In the present study, lithologies can be described in more detail for Cycle G of Section 2 as a typical cycle (Fig. 3b). The base at locality 14 is a fine sandstone (grain size <0.3 mm) approximately 3m thick. Above the sandstone six mudstone/siltstone units were identified by variation in colour. The first 3 m thick unit is a grey mudstone containing small carbonate nodules (up to 5 cm diameter), in which no fossils were found. This is overlain by another grey mudstone about 7 m thick, containing both fossil fish fragments and calcareous nodules. Above this is a 3 m orange mudstone layer, overlain by 1.5 m of dark red mudstone, both lacking fossil material, followed by a 5 m thick light grey mudstone producing osteolepid and arthrodire fish material at locality 17. Above this, another grey mudstone layer about 4.5 m thick contains large plant material (stems up to 30

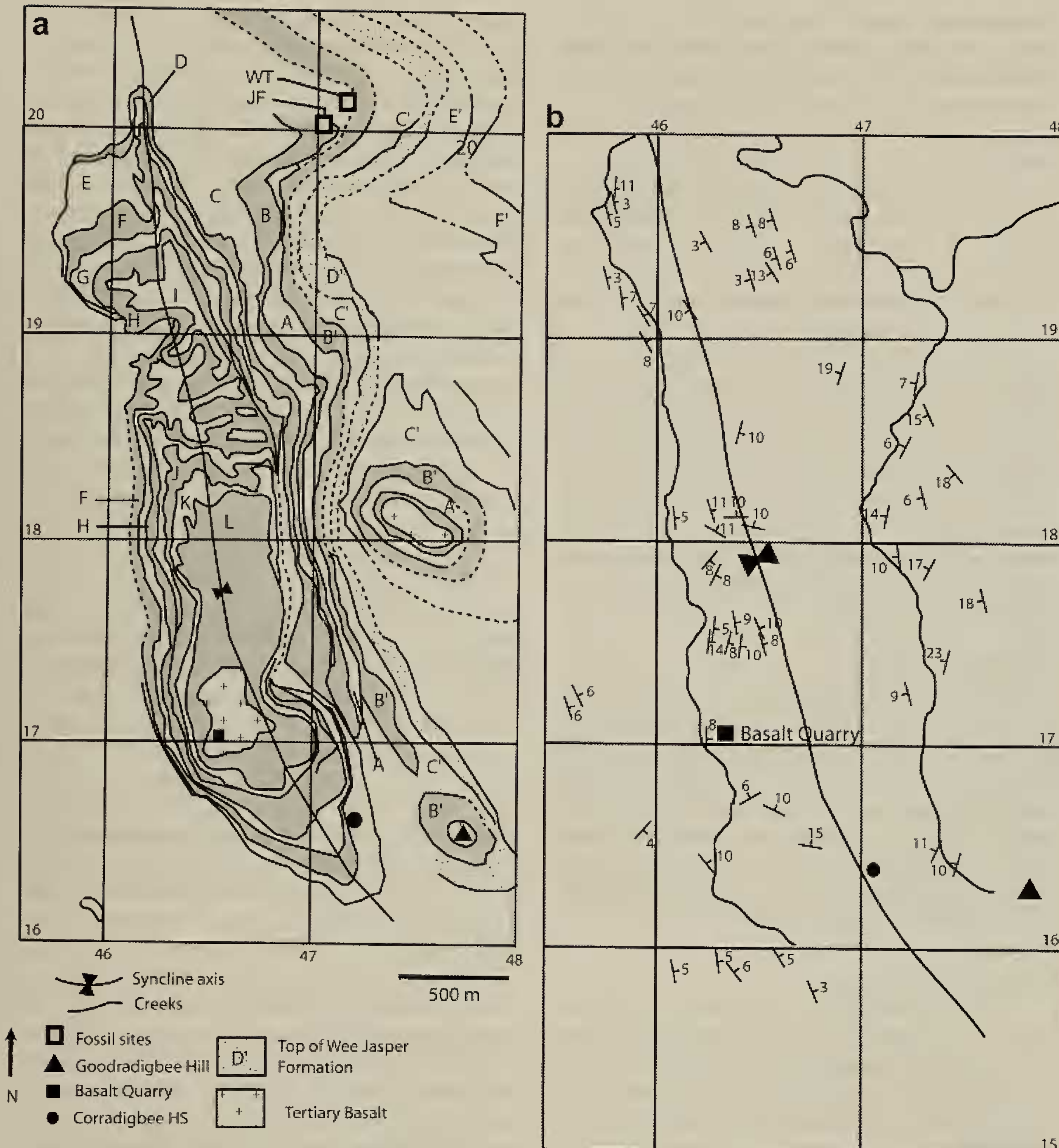


Figure 5. a. Outcrop map for the study area of the Corradigbee Formation. Cycles represented as alternating shaded and clear units to indicate outcrop pattern. b. Measured dips and strikes in relation to the syncline axis identified in this study.

cm in length) at the base, with fossil fish material and scattered plants above. The next sandstone layer marks the start of cycle H in this section (but correlated only approximately with an additional sandstone in cycle H of the type section).

Conglomerate

Conglomerates are very rare in the Corradigbee Formation. One thin (~ 8 cm) bed of pebbly red conglomerate was observed at locality 70 (near the middle of Cycle C). This contained small quartz pebbles, mudclasts, and mudballs generally less than 10 mm diameter, with generally rounded quartz pebbles and grains, although some of the smaller grains (<0.5 mm) were subangular. No fish fossils were observed in the conglomerate bed, but these occur immediately below in the mudstones (e.g. ANU V3171). Another thin (up to ~5 cm) bed of grey conglomerate was seen in erosion gullies at localities 98 and 138 (both probably in Cycle F), with quartz pebbles up to 20 mm diameter, and much fragmented fossil fish material giving the grey colour.

Sandstone

The sandstone layers at the base of each cycle vary in thickness, over 3 m thick in cycle F (Fig. 3b), but most are about 1.5 m thick. Sandstones within the cycles vary in the size of the sand grains but grain size is uniform within the bed itself. Grain size ranged from around <0.2 mm in each layer of sandstone, with some beds being finer than others. None of the sandstones in the formation were noted to be very coarse grained. Good exposures of the basal sandstones observed at localities 11, 14, 64, and 154 showed no cross-bedding, scour marks, mudclasts or other evidence of a river deposit. At only one locality (108, Cycle D) was some cross-bedding observed. Fish material found in the sandstones was disarticulated and fragmented (identified at only three localities 134, 138, JF).

Siltstone/Mudstone

Siltstones and mudstones in the formation vary in colour, from predominantly grey-black, to less common orange, red, dark purple and light grey lithologies. These colours are identified as primary on the evidence that the colour terminated with the bedding plane. In general, the red-purple colour phases are assumed to have formed in well-drained conditions, and the grey-black mudstones to indicate poorly drained swampy conditions.

Sedimentary structures

In the mudstones of the Corradigbee Formation calcareous nodules (up to 5 cm diameter) are abundant at many levels (common at localities 62, 97, 109, 128, 137 and 158, but noted at many other localities). They occur in both the red-purple and grey-black colour variations (largest examples were seen at locality 158, in Cycle B). In the Devonian Aztec Siltstone of Antarctica, common calcareous nodules were taken to indicate lengthy subaerial exposure (4,000-10,000 years) for pedogenic processes to operate (McPherson 1979). The same can be assumed here, except that the nodules are equally common in the red-purple and grey-black colour phases, the latter representing poorly drained swampy conditions, which would preclude pedogenesis. Cubic pyrite crystals were identified near fossil locality 161 (ANU 46692), consistent with the idea that the black mudstones formed under stagnant, anaerobic conditions.

Although laminar bedding was reported by Young and Gorter (1981) and Francis (2003) to indicate lacustrine conditions, only one occurrence of laminar bedding was observed in this study, in grey green mudstones at locality 24. Ripple marks were identified at localities 129, 130 and 131. Rather than lake deposits, the sedimentary structures indicate predominantly swampy conditions for the Corradigbee Formation, the whole Hatchery Creek sequence being interpreted as a humid alluvial fan.

Root casts were noted at various levels in the red and dark purple mudstones (Fig. 3b), in these cases indicating sub-aerial exposure and soil formation as do associated calcareous nodules. Apart from rain drop impressions at locality 80, no other dessication structures or mud crack horizons were observed in this study.

STRUCTURE

Young (1969) recorded measurements from the western side of the Goodradigbee valley indicating a fairly consistent dip in the limestones and overlying Hatchery Creek sequence, averaging 40° west with a strike of about 338°. A plot of bedding/axial plane cleavage intersections indicated a fold axis plunging 20-30° to the NW (315°). The uppermost limestone beds forming the contact with the northernmost exposure of the Hatchery Creek Conglomerate along the edge of Burrinjuck Dam (on the Yass 100K sheet) swing round a northern synclinal closure which limited data suggested plunged about 35° to the southwest (250°).

Owen and Wyborn (1979) showed only one anomalous easterly dip on the Brindabella 1:100 000 geological map for the upper part of the Hatchery Creek Conglomerate, interpreting the entire sequence as dipping to the west, the basis for their estimated 2.9 km total thickness. They suggested renewed uplift in the source area to explain a return to coarse conglomeratic cycles at the top of the sequence, but this can now be discounted (see above).

Their published cross sections (on the 1979 geological map) show the Hatchery Creek Conglomerate as a thick westerly-dipping section across the middle part of its outcrop (section A-B), and tightly folded in the southeastern extremity of the outcrop, with a steep to overturned western limb against the Long Plain Fault Zone (section E-F). Wyborn (1977) attributed this to thrusting of the rigid Goobarragandra Block over the Hatchery Creek Conglomerate, and no fold axis was indicated on the geological map. However, Edgell (1949) and Pedder et al. (1970) had previously shown a syncline axis running to the northwest towards the central part of our Corradigbee Formation. This structure, named the Wee Jasper Syncline by Hood and Durney (2002), runs through the area mapped in detail by Hunt (2005). New dip and strike measurements were recorded from 69 localities in and around the area of detailed mapping (see Appendix), and on both sides of the syncline axis, which was identified in the mapped area running through locality 21 and under the basalt cap of the central ridge (Fig. 1b), which is somewhat further to the west than the extrapolated position shown by Hood and Durney (2002, fig. 1). On the western side of the axis only easterly dips were measured, conforming to the one anomalous easterly dip of Owen and Wyborn's map, and in the same area Edgell's (1949) map shows 10° and 13° easterly dips. However, all measured dips were on the eastern side of the Western creek (representative measurements shown on Fig. 5b). We assume that the westerly dips previously shown on the Brindabella 1:100 000 geological sheet for the upper part of Corradigbee Formation outcrop must have been based on cleavage masking the bedding.

SUMMARY

Type sections are proposed for a new Corradigbee Formation, representing the upper fine-grained part of the Hatchery Creek sequence, comprising about 15 fining-upward cycles of sandstones, dark shales and mudstones in which 50 new fossil sites have been found.

The lower coarse-grained part of the Hatchery Creek sequence is renamed the Wee Jasper Formation, within a revised Hatchery Creek Group (total thickness about 1760 m). Thickness of the Wee Jasper Formation is estimated at about 1500 m, it is subdivided into four main fining upward cycles, and an additional type section is nominated for the upper part of the formation.

The Hatchery Creek Group is conformable on Lower Devonian limestones of the Murrumbidgee Group, thickness variations in the upper tidal flat deposits of the carbonate sequence being interpreted as depositional features.

Sedimentary structures indicate predominantly swampy rather than lacustrine conditions for the upper Corradigbee Formation, the whole Hatchery Creek sequence being interpreted as a humid alluvial fan.

The axis of a major syncline was identified, with previously unrecognised repetition of the lower coarse strata in the western part of the outcrop area resulting in a considerable over-estimate of total thickness in published literature. The relatively high topography of the softer shales and mudstones in the core of the syncline is a relatively transient topography resulting from recently eroded Tertiary basalts.

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APPENDIX

Abbreviations:
f = fish, p = plants, n =nodules, a = arthropods, r= root casts.
b = bioturbation, g = gastropods, impr = rain drop impressions.
x = cross bedding, lam = laminar bedding

2005 Localities	GRID REFERENCE	Horizon	Dip/Strike	Fossils and Structures
1	55 H 645457 6117228		6°E/345°	f
2	55 H 646000 6119045	G		
3	55 H 645626 6116656	F		p
4	55 H 646151 6118053			f
5	55 H 646519 6119415			f
6	55 H 646535 6119428		13°W/106°	f.p
7	55 H 646646 6119620	C		f
8	55 H 647280 6118881	D'	7°W/25°	x
9	55 H 647194 6118825	C'		
10	55 H 646906 6118728	B	19°W/10°	
11	55 H 646062 6118133		5°E/345°	
12	55 H 646093 6118127	F		
13	55 H 646125 6118108	F		
14	55 H 646121 6118105	G		
15	55 H 646154 6118073	G		f
16	55 H 646149 6118087	G		
17	55 H 646170 6118087	H		f.p.n
18	55 H 646179 6118060	H		f
19	55 H 646542 6118600	H		
20	55 H 646426 6118514	H	10E°/295°	
21	55 H 646418 6118061	K	10N/310°	
22	55 H 646455 6117973	L		
23	55 H 646600 6116644	D		p
24	55 H 647449 6116390	C	10°N/285°	f. lam
59	55 H 646709 6116402	E	15°N/95°	f
60	55 H 646585 6115979	E		p
61	55 H 646570 6116005	E		f
62	55 H 646552 6116007	E		n
63	55 H 646655 6116134	E		p
64	55 H 646543 6115914	E	5°E/120°	
65	55 H 646450 6115880	G		p
66	55 H 646199 6116092	E		
67	55 H 646261 6116124	E		
68	55 H 646237 6116362	E	10°E/120°	
69	55 H 646517 6116499	E		f
70	55 H 647411 6117304	C'	23°W/5°	f
71	55 H 647306 6117767	B'		r
72	55 H 647331 6117878	B'	17°W/210°	
73	55 H 647310 6118258	B	6°W/138°	
74	55 H 647373 6118281	D		p

75	55 H 647458 6118317	D	18°W/135°	r.b
76	55 H 647754 6117945	B	15°W/130°	
77	55 H 647465 6116410	A	9°W/148°	
78	55 H 647452 6116390	B	11°W/65°	
79	55 H 646479 6117559	M		f
80	55 H 646475 6117509	M	8°W/345°	f. impr
81	55 H 646432 6117481	L	10°E/185°	f
82	55 H 646408 6117475	J		f
83	55 H 646410 6117566	J	8°E/15°	
84	55 H 646404 6117569	J	9°E/140	f
85	55 H 646309 6117780	L		
86	55 H 646280 6117839	J	8°E/30	f
87	55 H 646238 6117838	L	8°E/30	f
88	55 H 646226 6117873	J		f
89	55 H 646218 6117934	J	8°E/50°	f
90	55 H 646224 6118003	J	11°N/70°	f
91	55 H 646235 6118092	J	11°E/180	f.a
92	55 H 646250 6118240	I		f
93	55 H 646422 6118054	I	10°N/110°	
94	55 H 646398 6118027	J	8°E/120°	
95	55 H 646433 6117488	L		
96	55 H 646342 6117551	I		p
97	55 H 646316 6117507	H		f
98	55 H 646279 6117544	I	14°E/310°	f
99	55 H 646207 6117646	G	5°E/310°	
100	55 H 646489 6119386	H	3°W/325°	f
101	55 H 646505 6119399	F		f
102	55 H 646506 6119407	E		f
103	55 H 646522 6119419	D	6°W/315°	f
104	55 H 646544 6119454	E		
105	55 H 646572 6119474	D	6°W/335°	f
106	55 H 646509 6119660	D		f.p
107	55 H 646487 6119618	D	8°W/335°	
108	55 H 646382 6119535	D	8°W/340°	p
109	55 H 646368 6119522	D		f.n
110	55 H 646218 6119567	H	3°W/310°	
111	55 H 646118 6119555	J		
112	55 H 645876 6119708	H		
113	55 H 645773 6119735	D	11°E/45°	
114	55 H 645727 6119736	D	3°E/325°	
115	55 H 645738 6119686	D	5°E/345°	
116	55 H 645779 6119398	C		
117	55 H 645788 6119395	C	3°E/335°	
118	55 H 645824 6119392	H		f
119	55 H 645914 6119367	J		
120	55 H 646583 6118459	I		f
121	55 H 646753 6115769	H		p
122	55 H 646740 6115768	G	3°E/330°	
123	55 H 646371 6115865	G	6°E/335°	
124	55 H 646453 6115883	E	5°E/356°	p

125	55 H 646090 6115893	E	5°E/355°	n
126	55 H 646011 6115953	F		
127	55 H 645950 6116511	G	4°E/30°	
128	55 H 645483 6120425	.	6°E/350°	n.b
129	55 H 646315 6121384	.	11°W/330°	b
130	55 H 646380 6121374	.	20°W/345°	b
131	55 H 646394 6121386	.	34°W/350°	b
132	55 H 646141 6119126	I		n
133	55 H 646036 6119138	F	10°E/335°	
134	55 H 645968 6119128	F		f
135	55 H 646244 6117558			f
136	55 H 645697 6119296	G		n
137	55 H 645734 6119219	G	7°E/350°	n
138	55 H 645965 6119015	F	8°E/315°	f
139	55 H 645848 6118845	F	6°E/310°	f.p
140	55 H 646434 6116715		6°E/40°	
141	55 H 646297 6117036	H	8°E/315°	f
142	55 H 646318 6117284			f
143	55 H 645979 6118978	H		f
144	55 H 645936 6119145	F	7°E/320°	f
145	55 H 645938 6119144	F		f
146	55 H 645947 6119148	F		f
147	55 H 645923 6119179	F		
148	55 H 646075 6118902	F		
149	55 H 646113 6118668	F		f
150	55 H 646115 6118654	H		p
151	55 H 646172 6118227	G		
152	55 H 647697 6117736	B’	18°W/350°	
153	55 H 647329 6117876	B’	10°W/310°	
154	55 H 647197 6117955	A	10°W/345°	n
155	55 H 647126 6118159	B	14°W/10°	
156	55 H 647090 6118284	D		p
157	55 H 647262 6118401	B	6°W/35°	
158	55 H 647375 6118448	B		n
159	55 H 647245 6116898	B		p

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2007/08 Localities	GRID REFERENCE	Horizon	Dip/Strike	Fossils and Structures
160	55 H 645457 6117228		6°E/345°	
161	55 H 646597 6118044	I		
062	55 H 647714 6118047	C'		p.g
063	55 H 647598 6117285	C'		
064	55 H 647328 6117162	C'	11°W/320°	b
065	55 H 647280 6117140	C'		b
066		A	14°W/352°	
067	55 H 647188 6117113	B		n
068	55 H 647793 6118228	C		
069	55 H 647766 6118251	B		f.p
070	55 H 647173 6117114	D		p.n.b
071	55 H 647155 6117111	E	14°W/320°	f
072	55 H 647114 6117413	F		
073	55 H 646093 6117410	G	6°W/340°	n
074	55 H 647073 6117404	H		
075	55 H 647068 6117404	H		
076	55 H 647031 6117389	H		
077	55 H 647006 6118570	H		
078	55 H 646982 6118563	H	14°W/40°	
079	55 H 646946 6118572	H		
080	55 H 646905 6118579	I	14°W/350°	
081	55 H 646851 6118549	J		f
082	55 H 646644 6118456	K		